Stratified Sand Filter Treatment Systems

Recommended Standards and Guidance for
Performance, Application, Design, and Operation and Maintenance

Washington State Department of
Health

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Preface

The recommended standards contained in this document have been developed for statewide application. Regional differences may, however, result in application of this technology in a manner different than it is presented here. In some localities, greater allowances than those described here may reasonably be granted. In other localities, allowances that are provided for in this document may be restricted. In either setting, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272 WAC and local jurisdictional rules. If any provision of these recommended standards is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the recommended standards presented here is at the full discretion of the local health officer.

Local jurisdictional application of these recommended standards may be:

1) **Adopted as part of local rules, regulations or ordinances—**When the recommended standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology—**The recommended standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these recommended standards may occur in a manner that combines these two approaches. How these recommended standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The recommended standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option. Other information and guidance is presented in text boxes with a modified font style to easily distinguish it from the recommended standards.

Acknowledgements—

The Department of Health Wastewater Management Program appreciates the contribution of many persons in the on-going development, review, and up-dating of the Recommended Standards and Guidance documents. The quality of this effort is much improved by the dedication, energy, and input from these persons, including:

- Geoflow, Inc.
- Lombardi and Associates
- Orenco Systems, Inc.
- Puget Sound Water Quality Action Team
- Sun-Mar Corporation
- Washington State On-Site Sewage Association (WOSSA)
- Washington State On-Site Sewage Treatment Technical Review Committee (TRC)
- Waste Water Technologies

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Introduction-

The stratified sand filter is a modified intermittent sand filter, the difference being the particle size and layering of the filter media. While this type of sand filter is an adaptation of proven water treatment technology, the on-site sewage treatment design/regulatory community has presently little "real world" experience with stratified sand filters. Wastewater, having received initial treatment in a septic tank, or equivalent wastewater sedimentation/initial treatment unit, is applied to a bed of media. This sand filter bed is constructed with layers of specific filter sand media, in sequential order, separated by supporting layers of gravel. Oxygen is provided to the sand/gravel interfaces by vent tubes placed throughout the filter. The wastewater is dispersed into a drain rock layer atop the sand bed by pressure distribution. Applied in doses, the wastewater flows downward as unsaturated flow through the media. Biological treatment occurs on the surface of the filter media particles. The treated wastewater (filtrate) is collected at the bottom of the sand filter, and discharged, either by gravity or by pressure, to a suitable, approved final treatment/disposal unit, usually a conventional sub-surface drainfield.

1. Performance Standards-

1.1. Performance Criteria-

1.1.1. Stratified sand filters when constructed and used according to these standards and guidance, are expected to perform to treatment standard 1 and 2 levels.

1.1.2. Effluent from a stratified sand filter can be discharged to 12 inches of vertical separation.

2. Application Standards-

2.1. Listing- Stratified sand filters are a generic alternative technology and therefore are not listed in the department's List of Approved Systems and Products as a proprietary system, but may be permitted by local health officers as there is a DOH Standard and Guidance document available.

2.2. Permitting-

2.2.1. Installation, and if required, operational, permits must be obtained from the appropriate local health officer prior to installation and use.

2.2.2. Interim Special Requirements For Stratified Sand Filters-To further our knowledge regarding the effectiveness and function of stratified sand filters under controlled conditions, the following requirements must be met for their use.

(a) A stratified sand filter be used only on sites which meet all the requirements for an intermittent sand filter.

(b) Before the local sewage system permit is issued, appropriate agreements and documents shall be produced and signed. These documents may include but are not limited to: easements, contracts, and performance or surety bonds, but must provide for:

- the sampling and testing required in item (c), below.
- the replacement of the filter media and reconstruction of the filter to the requirements for an intermittent sand filter if:
  - at any time in the two year period, sample results indicate that the stratified sand filter has failed to produce effluent quality equivalent to expectations for an intermittent sand filter, or
  - the stratified sand filter fails to function or perform to the satisfaction of the local health officer. This includes, but is not limited to, conditions such as

clogging or other failure of the media, and overflowing or other premature discharge of inadequately treated wastewater.

(c) For a two year period following commissioning, quarterly, 24-hour composite effluent samples shall be drawn and analyzed for TSS, BOD_5, Ammonium, Nitrate, and Fecal Coliform.

(d) In the future, the TRC will evaluate data collected from stratified sand filters in use in Washington State and re-evaluate the continued necessity for imposing the additional requirements listed above.

2.3. Influent Characteristics

2.3.1. Residential Wastewater: Stratified sand filters are designed for treating residential strength wastewater. The wastewater applied to the stratified sand filter must not be higher in strength than 220 mg/l BOD_5 or 145 mg/l TSS (no TSS particles should be retained on a 1/8 inch mesh screen). Lower wastewater strengths, without increased flow rates are preferable for assuring long term operation of an stratified sand filter system.

2.3.2. Non-Residential Wastewater: High-strength wastewater and wastewater from non-domestic sources (such as restaurants, hotels, bed and breakfast establishments, industrial and commercial wastewater sources) must be individually evaluated for treatability and degree of pretreatment required prior to a stratified sand filter for final treatment and disposal.

2.3.3. Daily Wastewater Flow

(a) Residential -- For all residential applications, a minimum wastewater design flow of at least 120 gallons/bedroom/day must be used.

(b) Non-Residential -- For non-residential applications, a minimum wastewater design flow equal to 150% of the estimated daily flow should be used.

2.4. Pretreatment -

2.4.1. If the wastewater is residential sewage, settleable and floatable solid separation by a properly sized two-compartment septic tank with effluent baffle screening will suffice.

Pretreatment with some other wastewater sedimentation/initial treatment unit may be used instead of a septic tank.

2.4.2. If the wastewater is from a non-domestic source, influent to the sand filter must be equivalent to residential strength septic tank effluent.

Aerobic treatment or some other treatment process may be needed to modify the influent to the stratified sand filter to within the range of residential septic tank effluent quality.

2.5. Location Requirements - The minimum setback requirements for stratified sand filters are the same as those required for septic tanks in WAC 246-272-09501.

2.6. Installation Issues

2.6.1. If the containment vessel is constructed of a 30 mil PVC liner, the liner must be protected by a 3 inch layer of sand beneath the liner.

2.7. Disposal Component—

2.7.1. Direct discharge of effluent from an stratified sand filter to surface water or upon the ground surface is prohibited by WAC 246-272-11501(2)(a). Subsurface disposal is required.

2.7.2. Drainfield design allowances vary according to treatment performance levels. Refer to the Recommended Standards and Guidance for Effluent Quality-Based Drainfields DOH (***Effective Date: 5/15/00***).

2.7.3. The size and design of the disposal component must be consistent with the methods and procedures indicated by WAC 246-272-09001, WAC 246-272-11001 and WAC 246-272-11501.

2.7.4. Disposal component location must meet minimum horizontal setback distances as specified by WAC 246-272-09501, and 246-272-16501.

2.7.5. Development using an stratified sand filter must meet the minimum land area requirements specified in WAC 246-272-20501.

3. Design Standards –

3.1. Design Approval – Before construction can begin, the design must be approved by local health or other appropriate jurisdiction. All site inspections before, during, and after the construction must be accomplished by local health, other appropriate jurisdiction, or by a designer or engineer appointed by the appropriate jurisdiction.

3.2. Filter Bed

3.2.1. Media Specifications

(a) Filter media must meet the particle size criteria detailed in Appendix B. Media used in constructing a stratified sand filter must be accompanied with a written certification from the supplier that the media fully conforms to the particle size criteria as determined by ASTM D136 and ASTM C-117.

(b) Layer thickness, support gravel placement (See Figure 2 of Appendix A):

Top Layer - 10 inches thick,
Supported by a 4 inch thick layer of 3/4 inch gravel.

Middle Layer - 4 inches thick,
Supported by a 4 inch thick layer of 3/4 inch gravel.

Bottom Layer - 10 inches thick,
Supported and underdrained by gravel and pipe.
(See Appendix D. Underdrains)

(c) Surfaces of each layer must be level before adding the next layer.

3.2.2. Loading Rate: The loading rate shall not exceed 1.2 gallons/day/square foot, using the appropriate daily wastewater flow design estimate.

3.2.3. Surface area of filter bed: The surface area must be determined by dividing the design flow estimate by the loading rate.

3.3. Depth (thickness) of media sand and corresponding support gravels: shall be as indicated in Section 3.2.1(b), and in Figure 2 of Appendix A.

3.4. Filter bed containment: The filter bed is contained either in a flexible membrane-lined pit, or a concrete vessel. Design and construction must conform with the containment standards set forth in Appendix C.

3.5. Vent tubes:

3.5.1. Vent tubes are an integral component of the stratified filter. Their number and placement must meet the requirements indicated in Figures 2 and 3 of Appendix A.

3.5.2. Each tube must be constructed from 4 inch diameter or larger pipe manufactured according to ASTM D 3034 standards. Each vent must have a threaded cap at the top end, which extends above final grade, to prevent unwanted objects from entering the filter. Venting is provided by a series of 30, 1/8 inch diameter holes located in the vent tube corresponding to each of the gravel layers, the base support gravel at the bottom of the filter, and around the cap on top of the vent. (This would equate to a total of 120 each, 1/8 inch diameter holes in each vent tube) If the drilled holes are covered with 1/8th inch plastic mesh suitable for possible corrosive conditions within the filter environment, eight, 1/2 inch diameter holes at each of the respective locations, may be used. See Figure 2 of Appendix A.

3.6. Wastewater Distribution

3.6.1. Pressure distribution: Pressure distribution is required and must comply with the pressure distribution standards and guidance. This requirement applies to all pressure distribution related components.

3.6.2. Wastewater application to the filter bed: The wastewater must be applied to the layer of drain rock atop the filter media, or sprayed upward against the top of gravelless chambers.

3.6.3. Treated Wastewater (Filtrate) Collection & Discharge -- Filtrate may be collected and discharged from the bottom of the sand filter by either a gravity-flow underdrain system, or a pressure-flow pumpwell system. When sand filters are membrane-lined, gravity-flow underdrains must exit through a boot, and the boot and exit pipe must be installed and tested according to the standards in Appendix C.

4. Operation and Maintenance –

4.1. Management -- The local health officer has the authority to require that an acceptable maintenance agreement be established, and supporting documents be developed and approved by the local health officer, prior to the issuance of approvals for a proposed sand filter sewage system. It is recommended that a maintenance agreement be required when, in the opinion of the local health authority, the ongoing operation of the sand filter sewage systems is best assured by the existence of such an agreement.

4.2. User's Manual -- A user's manual for the sand filter system must be developed and / or provided by the system designer. These materials must contain the following, at a minimum:

(a) Diagrams of the system components

(b) Explanation of general system function, operational expectations, owner responsibility, etc.

(c) Names and telephone numbers of the system designer, local health authority, component manufacturer, supplier/installer, and/or the management entity to be contacted in the event of a failure.

(d) Information on "Trouble-shooting" common operational problems that might occur. This information should be as detailed and complete as needed to assist the system owner to make

accurate decisions about when and how to attempt corrections of operational problems, and when to call for professional assistance.

(e) For proprietary sand filter devices, a complete maintenance and operation document must be developed and provided by the manufacturer. This document must be made available, through the system designer, to the system owner. This document must include all the appropriate items mentioned above, plus any additional general and site-specific information useful to the system owner, and/or the maintenance person. A copy of this document must also be provided to the local health authority, prior to the issuance of the local installation permit.

4.3. Maintenance

4.3.1.Responsibility -- For the on-site treatment and disposal system to operate properly, its various components need periodic inspection and maintenance. The maintenance is the responsibility of the homeowner, but may be best performed by experienced and qualified service providers. An Operation and Maintenance Manual must be developed and/or provided by the system designer with copies provided to the local health officer, system owner and maintenance contractor. The maintenance manual must include the following listed recommended maintenance descriptions and schedules. The local health officer may specify additional requirements.

4.3.2.Minimum Maintenance Description and Service Items

4.3.2.1. Type of use.

4.3.2.2. Age of system.

4.3.2.3. Specifications of all electrical and mechanical components installed (occasionally components other than those specified on the plans are used).

4.3.2.4. Nuisance factors, such as odors or user complaints.

4.3.2.5. Septic tank: inspect yearly for structural integrity, proper baffling, screen, ground water intrusion, and proper sizing. Inspect and clean effluent baffle screen and also pump tank as needed

4.3.2.6. Pump chamber: clean the effluent screen (spraying with a hose is a common cleaning method), inspect and clean the pump switches and floats yearly. Pump the accumulated sludge from the bottom of the chambers, whenever the septic tank is pumped, or more often if necessary.

4.3.2.7. Pumpwell: Inspect for infiltration, structural problems and improper liquid level. Check for pump or siphon malfunctions, including problems related to dosing volume, pressurization, breakdown, clogging, burnout, or cycling. Pump the accumulated sludge from the bottom of the pumpwell, whenever the septic tank is pumped, or whenever necessary.

The liquid level at the pump start or siphon must be below the bottom of the filter media in order to prevent ponding and rise of the capillary fringe in the sand. Improper liquid level (too high in the pumpwell) can result from improper setting of the pump on float, pump burnout, disconnected electrical supply to the pump or controls, or tripped circuit breaker. In some cases the underdrain may be underdesigned and may not have the flow capacity to supply the pump at the rate that it pumps. Infiltration into the pumpwell is serious and means that the effluent is entering the pumpwell before passing through the full column of sand. Effluent that is short circuiting will not receive full sand filter treatment.

4.3.2.8. Check monitoring ports for ponding. Conditions in the monitoring ports must be observed and recorded by the service provider during all operation and maintenance activities for the sand filter and other system components.

4.3.2.9. Inspect and test yearly for malfunction of electrical equipment such as timers, counters, control boxes, pump switches, floats, alarm system, junction box, or other electrical components, and repair as needed. System checks should include improper setting or failure, of electrical, mechanical, or manual switches.

4.3.2.10. Mechanical malfunctions (other than those affecting sewage pumps) including problems with valves, or other mechanical or plumbing components.

4.3.2.11. Material fatigue, failure, corrosion problems, or use of improper materials, as related to construction or structural design.

4.3.2.12. Neglect or improper use, such as loading beyond the design rate, poor maintenance, or excessive weed growth.

4.3.2.13. Installation problems, such as improper location or failure to follow design.

4.3.2.14. Overflow or backup problems where sewage is involved.

4.3.2.15. Specific chemical/biological indicators, such as BOD, TSS, fecal coliforms, etc. Sampling and testing may be required by the local health officer on a case-by-case basis, depending on the nature of the problem, availability of laboratories, or other factors.

4.3.2.16. Information on the safe disposal of discarded filter media. See Appendix F.

4.4. Action Conditions -- When inspections, or any other observation, reveals either of the following listed conditions, the owner of the system must take appropriate action, according to the direction and satisfaction of the local health officer:

(a) drainfield system failure, as defined in WAC 246-272-01001, or

(b) stratified sand filter fails to function or perform to the satisfaction of local health officer and/or fails to produce effluent quality equivalent to expectations for an intermittent sand filter (see Section 2.2.2(b)).

4.4.1. Appropriate Actions Upon Identification of Action conditions:

- repair or modification of the drainfield system,
- expansion of the drainfield system,
- modifications or changes within the structure relative to wastewater strength or hydraulic flows,
- replacement of the stratified sand filter in accordance with Section 2.2.2(b).

Appendix A-- Figures

Figure 1: Typical Layout Of A Stratified Sand Filter

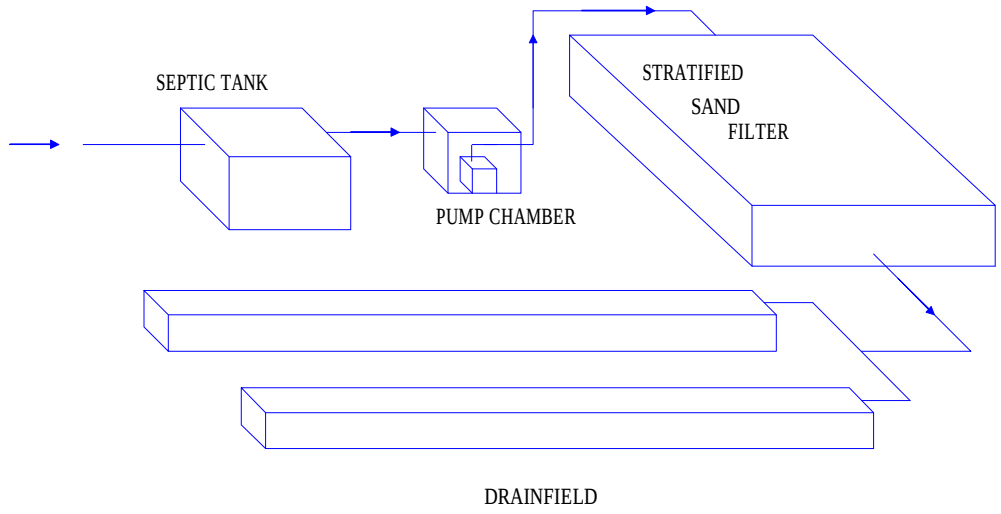


Figure 2: Typical Cross-section Of A Stratified Sand Filter, With Depth and Specification of Sand Material.

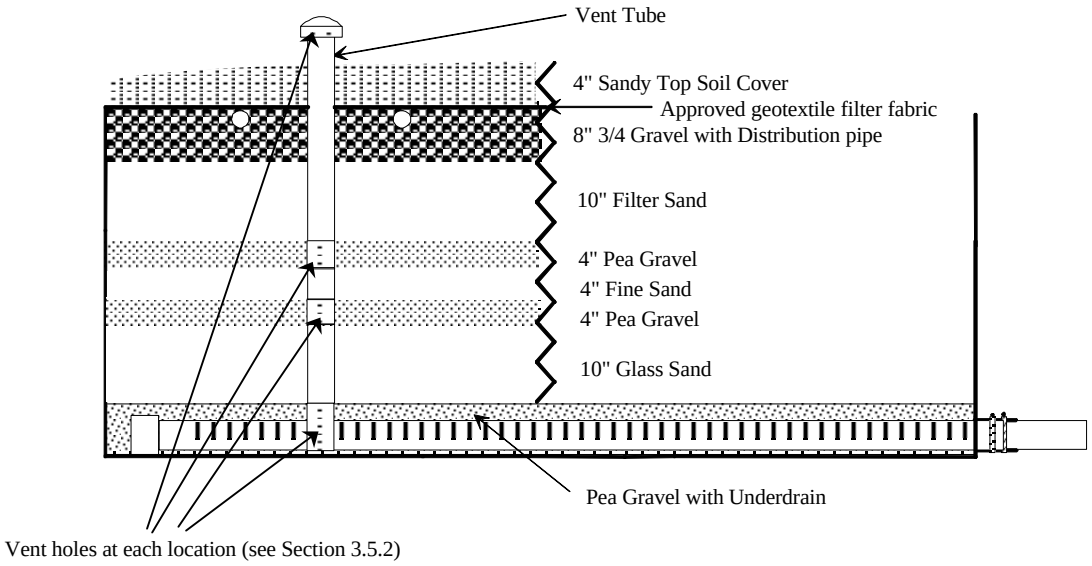
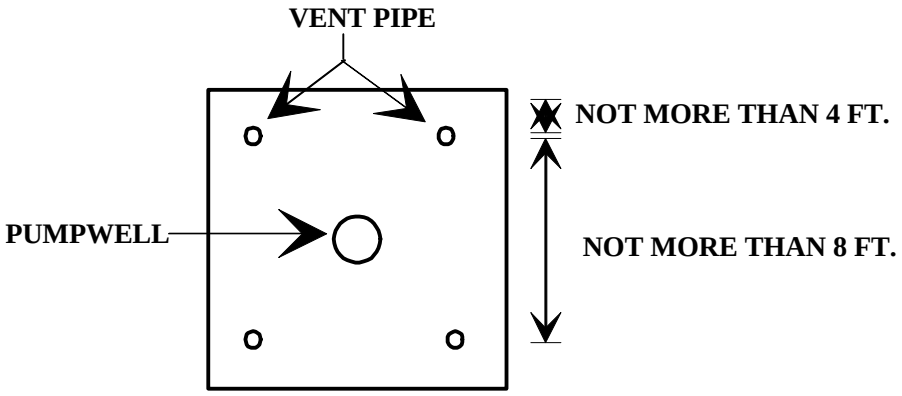


Figure 3: Typical Vent Pipe Layout, Top View



Appendix B-- Filter Media Specifications

A. Particle Size Analysis

The standard method to be used for performing particle size analysis must comply with one of the following:

1. the sieve method specified in ASTM D136 and ASTM C-117
2. the method specified in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples, Soil Survey Investigation Report #1, US Department of Agriculture, 1984.

B. Stratified Sand Filter

Particle size distribution:

TOP LAYER	
Particle Size	**Percent Retained**
2.00 mm	0
1.40 mm	0 to 14
1.18 mm	3 to 32
.850 mm	28 to 86
.600 mm	63 to 97
.425 mm	84 to 100
.300 mm	96 to 100

MIDDLE LAYER	
Particle Size	**Percent Retained**
.850 mm	0 to 2
.600 mm	7 to 17
.425 mm	37 to 61
.300 mm	83 to 89
.212 mm	97 to 99
.180 mm	99 to 100
.150 mm	100

BOTTOM LAYER	
Particle Size	**Percent Retained**
.850 mm	0
.600 mm	<1
.425 mm	9 to 11
.150 mm	94 to 96
.106 mm	99
0.75 mm	100

Appendix C -- Containment Vessel Standards

A. Lined Pit: when a sand filter is constructed in an excavated pit the following criteria are to be met. (Note: The majority of the following liner specification is from the State of Oregon On-Site Sewage Disposal Rules.)

1. Polyvinyl chloride (PVC) shall have the following properties:

PROPERTY	TEST METHOD	
(a) Thickness	ASTM D1593 Para 9.1.3	30 mil minimum
(b) Specific Gravity (Minimum)	ASTM D792 Method A	
(c) Minimum Tensile Properties (each direction)	ASTM D882	
(A) Breaking Factor (pounds/inch width)	Method A or B (1 inch wide)	69
(B) Elongation at Break (percent)	Method A or B	300
(C) Modulus (force) at 100% Elongation (pounds/inch width)	Method A or B	27
(d) Tear Resistance (pounds, minimum)	ASTM D1004 Die C	8
(e) Low Temperature	ASTM D1790	-20°F
(f) Dimensional Stability (each direction, percent change maximum)	ASTM D1204 212°F, 15 min.	± 5
(g) Water Extraction	ASTM D1239	-0.35% max.
(h) Volatile Loss	ASTM D1203 Method A	0.7% max.
(I) Resistance to Soil Burial (percent change maximum in original value)	ASTM D3083	
(A) Breaking Factor		-5
(B) Elongation at Break		-20
(C) Modulus at 100% Elongation		±10
(j) Bonded Seam Strength (factory seam, breaking factor, ppi width)	ASTM D3083	55.2
(k) Hydrostatic Resistance	ASTM D751 Method A	82

2. Installation Standards:

(a) Patches, repairs and seams shall have the same physical properties as the parent material;

(b) Site considerations and preparation:

(A) The supporting surface slopes and foundation to accept the liner shall be stable and structurally sound including appropriate compaction. Particular attention shall be paid to the potential of sink hole development and differential settlement;

(B) Soil stabilizers such as cementations or chemical binding agents shall not adversely affect the membrane; cementations and chemical binding agents may be potentially abrasive agents.

(c) To avoid deterioration of the membrane liner caused by exposure to weather or sunlight, the liner must be protected by being fully buried. In cases where portions of the liner may be subject to direct exposure to the weather (for example in a recirculating gravel filter system in which the top edges of the liner may not be buried due to the system design requirements), the exposed portions of the liner must be covered. (An example might be to construct a finish rim over the exposed liner portions.)

(d) Non-reinforced liners have high elongation and can conform to irregular surfaces and follow settlements within limits. Unreasonable strain reduces thickness and may reduce life expectancy by lessening the chemical resistance of the thinner (stretched) material. Every effort shall be made to minimize the strain (or elongation) anywhere in the flexible membrane liner;

(e) Construction and installation:

(A) Pit / surface / preparation:

(i) bottom of pit:

(I) covered with sand to "bed" liner, adequate in depth (minimum 3") to protect liner from puncture, or

(II) use a non-woven needle-punched synthetic geotextile fabric, in a thickness appropriate to the tasks of protecting the liner.

(III) sides of the pit smooth, free of possible puncture points.

(IV) bottom of pit (bedding layer of sand) graded to provide a sloping liner surface, from the outer edge of the filter toward the point of underdrain collection. Slope equal to 8 inches fall overall or one inch of fall per foot of run, whichever is the greatest.

(B) Climatic conditions:

(i) Temperature. The desirable temperature range for membrane installation is 42° F to 78° F. Lower or higher temperatures may have an adverse effect on transportation, storage, field handling and placement, seaming and backfilling and attaching boots and patches may be difficult. Placing liner outside the desirable temperature range shall be avoided;

(ii) Wind. Wind may have an adverse effect on liner installation such as interfering with liner placement. Mechanical damage may result. Cleanliness of areas for boot connection and patching may not be possible. Alignment of seams and cleanliness may not be possible. Placing the liner in high wind shall be avoided;

(iii) Precipitation. When field seaming is adversely affected by moisture, portable protective structures and/or other methods shall be used to maintain a dry sealing surface. Proper surface preparation for bonding boots and patches may not be possible. Seaming, patching and attaching 'boots' shall be done under dry conditions.

(C) Boots: When boots are used (required when using a gravity-flow underdrain), the boot and exit pipe must be installed with the following criteria:

(i) The system designer is to identify the use of a sand filter liner with underdrain and boot as a part of the application for on-site sewage system and provide specifications detailing design and installation requirements.

(ii) The boot is to be installed by the manufacturer or the manufacturer's representative.

(iii) The boot outlet is to be bedded in sand.

(iv) The boot is to be sized to accommodate an underdrain outlet pipe.

(v) The boot is to be secured to the underdrain outlet pipe with two (2) stainless steel bands and screws, and sealant strips as recommended by the manufacturer.

(vi) The underdrain is to be designed in accordance with Appendix C, Underdrains and exit the side of the liner.

(vii) An inspection port must be installed in the sewer pipe from the sand filter to the drainfield.

(viii) Sewer pipe from the sand filter to the drainfield must be ASTM 3034 ring tight.

(ix) When site conditions are such that the trench from the sand filter to the drainfield may act as a conduit for ground water movement towards the drainfield (for example on sites with shallow groundwater of poorly drained sites), the trench must be back-filled with a minimum 5 lineal feet clay mix (or bentonite mix) dam.

(x) If the boot may be submerged in a seasonal high water table, performance testing of the sand filter/boot for leakage must be conducted in the following manner:

(A) Block outlet pipe;

(B) Fill underdrain gravel with water;

(C) Measure and record elevation of water through observation/inspection port;

(D) Let stand 24 hours minimum;

(E) Measure and record elevation of water through observation/inspection port;

(F) No allowable drop in the water level.

(D) Liner Placement:

(i) Size. The final cut size of the liner shall be carefully determined and ordered to generously fit the container geometry without field seaming or excess straining of the linear material;

(ii) Transportation, handling and storage. Transportation, handling and storage procedures shall be planned to prevent material damage. Material shall be stored in an secured area and protected from adverse weather;

(iii) Site inspection. A site inspection shall be carried out by local health officer, other appropriate jurisdiction or by a designer or engineer appointed by the appropriate jurisdiction. and the installer prior to liner installation to verify surface conditions, etc.;

(iv) Deployment. Panels shall be positioned to minimize handling. Seaming should not be necessary. Bridging or stressed conditions shall be avoided with proper slack allowances for shrinkage. The liner shall be secured to prevent movement and promptly backfilled;

(v) Anchoring trenches. The liner edges should be secured frequently in a backfilled trench;

(vi) Field seaming. Field seaming, if absolutely necessary, shall only be attempted when weather conditions are favorable. The contact surfaces of the materials should be clean of dirt, dust, moisture, or other foreign materials. The contact surfaces shall be aligned with sufficient overlap and bonded in accordance with the suppliers recommended procedures. Wrinkles shall be smoothed out and seams should be inspected by non-destructive testing techniques to verify their integrity. As seaming occurs during installation, the field seams shall be inspected continuously and any faulty area repaired immediately;

(vii) Field repairs. It is important that traffic on the lined area be minimized. Any necessary repairs to the liner shall be patched using the same lining material and following the recommended procedure of the supplier;

(viii) Final inspection and acceptance. Completed liner installations shall be visually checked for punctures, rips, tears and seam discontinuities before placement of any backfill. At this time the installer shall also manually check all factory and field seams with an appropriate tool. In lieu of or in addition to manual checking of seams by the installer, either of the following tests may be performed;

(I) Wet Test: The lined basin shall be flooded to the one (1) foot level with water after inlets and outlets have been plugged. There shall not be any loss of water in a 24 hour test period.

(II) Air Lance Test: Check all bonded seams using a minimum 50 PSI (gauge) air supply directed through a 3/16 inch (typical) nozzle, held not more than 2 inches from the seam edge and directed at the seam edge. Riffles indicate unbonded areas within the seam, or other undesirable seam construction.

B. Lined Framework: A perimeter support frame to hold the liner in place during construction may be used. Framework shall be straight, free from warps or bends. Framework shall be of sufficient rigidity so that springing will not occur under the weight of the media and/or backfill placement. Framework shall be sufficiently supported to prevent excessive deflection of the framework.

Plywood with 2x4 framing support (on minimum 2' centers) is a suggested method. Treated wood should be used to prevent deterioration of the wood by termites, decomposition, etc.

1. Media and liner placement:

a. It is important that sand is placed between the framework and excavated soil simultaneously with placement of the treatment media. This keeps the framework and liner vertical during the course of construction and results in a sand cushion around the outside perimeter of the lined framework. All nails or staples used must have their sharp ends pointed away from the liner. The PVC liner is unfolded from the center of the excavation and draped over the top edges of the perimeter support frame. Care should be taken to prevent contact between the liner and the sharp edges of the top of the perimeter support frame.

A garden hose which has been cut longitudinally and placed on the top edge of the support frame, would be a suggested method.

b. Care must be taken to ensure that the liner is in full contact with the bottom and sides and that no bridging occurs.

Pleats or wrinkles in the liner should be minimized. Pleats and wrinkles in the liner may allow for a tunneling effect of effluent through the pleat or wrinkle.

2. Backfill around framework: If site conditions are such that a partially elevated filter is desired or necessary, backfill around the sides of the filter shall be non-clay material containing no pieces more than 3 inches across, no frozen lumps and no wood or other foreign material. The backfill material around the sides of the filter shall be placed in layers no more than 2 feet thick (loose), with each layer tamped and graded so that final settling will provide for side slopes on the sides of the filter backfill to be approximately 3:1 from the top of the filter, to native ground.

C. Concrete Containment Vessel:

1. Above ground tank. to be designed and/or approved by a qualified professional engineer if the following conditions are <u>not</u> met.

   a. Walls

      (1) at least 6 inches thick

      (2) Above ground height is 4 feet or less

      (3) rebar reinforcement: 3/8 inch diameter rebar on 2-foot centers horizontally and vertically, with continuous lengths wrapped around the corners.

   b. Floor

      (1) at least 3 1/2 inches thick

      (2) reinforced with steel mesh (CRSI standard #6-1010) to prevent cracking and to maintain water-tightness

   c. Tank is to be designed, constructed, and sealed to be water-tight.

2. Below ground tank.

   Any below-ground concrete tank must be water-tight. The design of any such tank is to be approved by a qualified professional engineer and, where required by local and/or state regulation, the local health officer.

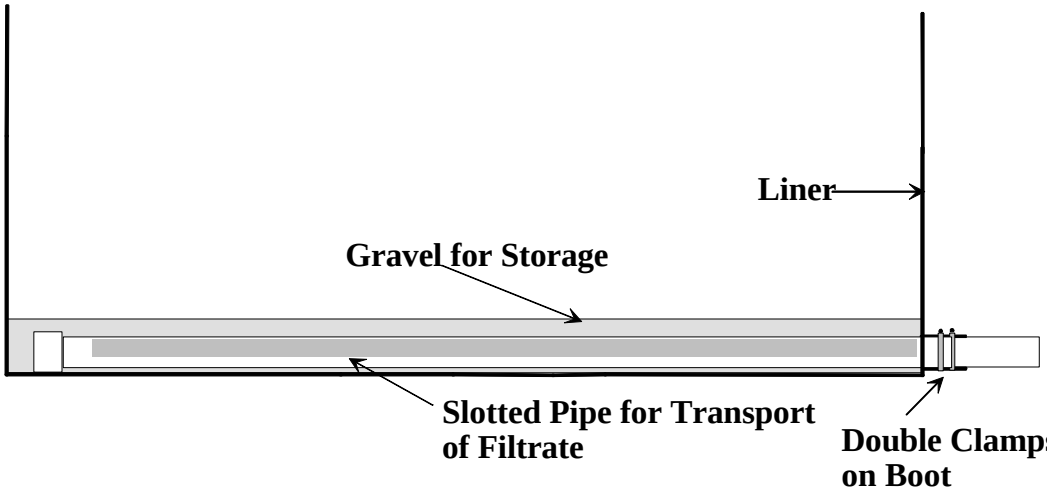
Appendix D -- Underdrains

A. **For Concrete Tanks or Synthetic Membrane-Lined Pits:** Either gravity underdrains or pumpwells may be used.

B. **Underdrains:** Underdrains must be designed with sufficient void storage volume to provide for a single drainfield dose with reserve capacity to maintain unsaturated filter media above the underdrain system. Collection pipe must be sized of sufficient size, with adequate perforations, or slots so that filtrate can flow from the void storage space into the collection pipe rapidly enough to maintain unsaturated filter media above the underdrain system. However, the minimum size of the collection pipe shall be 4" diameter. Underdrains may be designed in a variety of ways.

One possible way is:

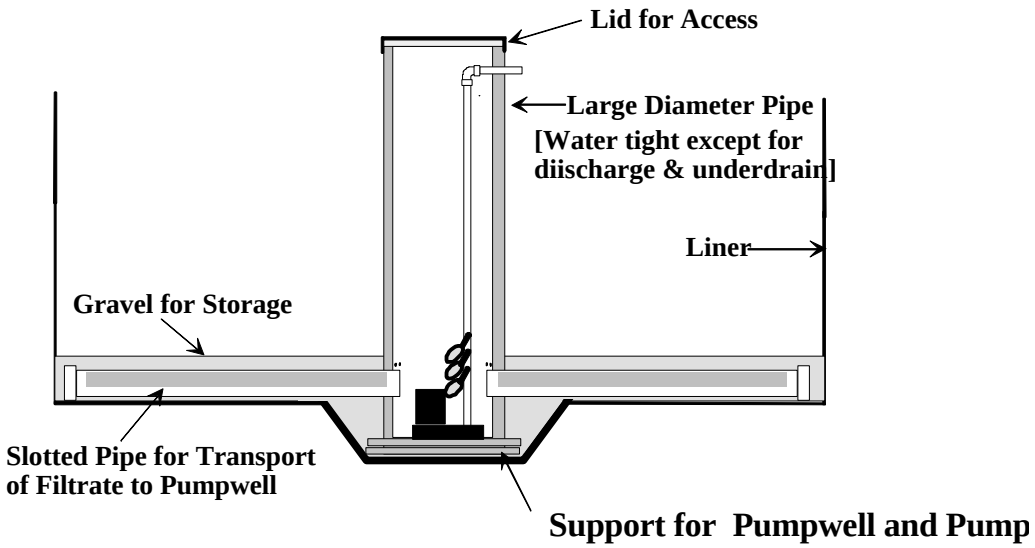
Place a 3 inch layer of pea gravel over a 6 inch layer of 3/4 to 2-1/2 inch gravel containing the underdrain collection pipe. The purpose of the pea gravel is to restrict the migration of sand into the gravel and pipe in the underdrain. The gravel surrounding the slotted or perforated pipe should be sized larger than the slots or perforations to prevent migration of gravel into the pipe. See Figure 1. For the purpose of calculating void storage space in the medium gravel (3/4 to 2-1/2 inch), 3.0 gallons per cubic foot may be used assuming 40% void space per cubic foot.



Typical Cross-section Of An Stratified Sand Filter Underdrain

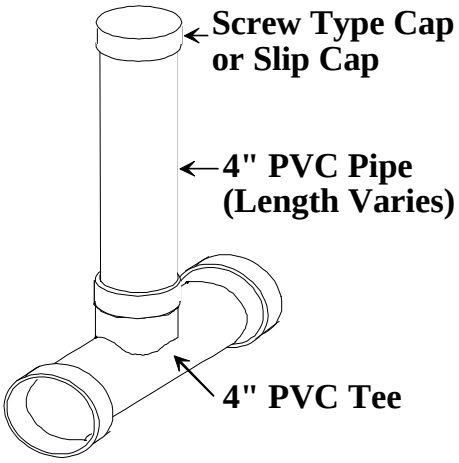
C. Pumpwells: are located within the filter. Filtrate is collected in a underdrain system underlying the filter media and is discharged directly into the pumpwell.

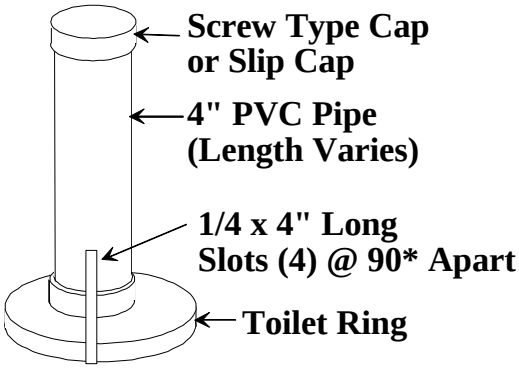
Pumpwells may be designed a variety of ways, but they must be constructed of concrete or plastic sewer pipe. A sufficient number and size of holes must exist in the pumpwell, at the level of the underdrain system, so that filtrate can flow into the pumpwell, from the underdrain void space, as rapidly as the filtrate is pumped out of the pumpwell. The pumpwell must be adequately supported on both sides of the synthetic membrane.

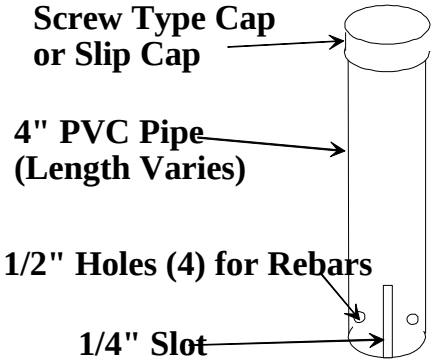


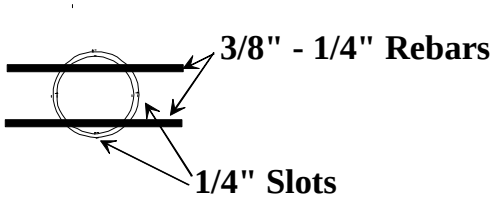
Typical Cross-section of a Pumpwell In A Synthetic Membrane-lined Stratified Sand Filter

Appendix E--Inspection/Monitor Ports









END VIEW (BOTTOM)

Appendix F -- Disposal of Contaminated Filter Media

Whenever filter media is removed from a used filter, removing and disposing of contaminated filter media is to be done in a manner approved by the local health officer. Handle this material carefully, using adequate protective sanitation measures. Thoroughly wash hands and any other exposed skin with hot water and soap, following contact with contaminated sand filter media.

This material may be applied to the soil, according to the following, only when approved by the local health officer.

APPLICATION	**RESTRICTIONS/TIMETABLE**
1. Root crops, low-growing vegetables, fruits, berries used for human consumption.	Contaminated material must be stabilized and applied 12 months prior to planting.
2. Forage and pasture crops for consumption by dairy cattle.	Forage and pasture crops not available until one month following application of stabilized material.
3. Forage and pasture crops for consumption by non-dairy livestock.	Forage and pasture crops not available until two weeks following application of stabilized material.
4. Orchards or other agricultural area where the material will not directly contact food products. Or where stabilized material has undergone further treatment, such as pathogen reduction or sterilization.	Less severe restrictions may be applicable.

Appendix G

Glossary of Terms -

Term	Meaning / Description
Alternative System	An on-site sewage system other than a conventional gravity system or conventional pressure distribution system. Properly and maintained alternative systems provide equivalent or enhanced treatment performance as compared to conventional gravity systems.
Approved List	"List of Approved Systems and Products", developed annually and maintained by the department and containing the following: List of proprietary devices approved by the department; List of specific systems meeting Treatment Standard 1 and Treatment Standard 2; List of experimental systems approved by the department; List of septic tanks, pump chambers, and holding tanks approved by the department.
Biological Oxygen Demand (BOD_5)	A test which measures the molecular oxygen used by microorganisms during a five day incubation period at a temperature of 20^0C (68^0F) for the biochemical degradation of organic material (CARBONACEOUS DEMAND), and the oxygen used by microorganisms to oxidize inorganic material such as sulfides and ferrous iron. It also may measure the amount of oxygen used to oxidize reduced forms of nitrogen such as ammonia and organic nitrogen (NITROGENOUS DEMAND) if the microorganisms capable of mediating the reaction are present in the sample. .
Carbonaceous Biological Oxygen Demand ($CBOD_5$)	Same as the 5-day biochemical oxygen demand (BOD_5) test, except that the NITROGENOUS DEMAND is prevented by addition of an inhibitory chemical to the sample.
Coliform (Bacteria)	A group of bacteria that produce gas and ferment lactose, some of which are found in the intestinal tract of warm-blooded animals. They are indicators of potential ground water and/or surface water contamination with such fecal material. The coliform group of organisms includes all of the aerobic and facultative anaerobic, gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 35^o C.
Conventional Gravity System	An on-site sewage system consisting of a septic tank and a subsurface soil absorption system with gravity flow distribution of the effluent.
Conventional Pressure Distribution System	An on-site sewage system consisting of a septic tank and a subsurface soil absorption system with pressure distribution of the effluent.
Demand System	Any system where the dosing frequency (or flow to a treatment or disposal component) is controlled by the volume of effluent flowing to the component. For a demand system containing a pump and pressure distribution system, the pump turns on when sufficient volumes (demand) flow into the chamber causing the pump-on float to activate and the predetermined dose volume to be discharged to the treatment and / or disposal component which follows.
Disposal Component	A subsurface absorption system (SSAS) or other soil absorption system receiving septic tank or other pretreatment device and transmitting it into original, undisturbed soil.
Dosing Tank / Chamber	A tank which collects treated effluent and periodically discharges it into another treatment / disposal component, depending upon the needs and design of the particular on-site sewage system.
Drain Rock	Clean, washed gravel, varying in size from ¾inch to 2 ½inches.
Drainfield (Conventional)	An area in which perforated piping is laid in drain rock-packed trenches, or excavations (seepage beds) for the purpose of distributing the effluent from a wastewater treatment unit into original, undisturbed soil.
Effective Particle Size, CE=C90	The size of opening of an ideal sieve which would retain 90% of a sample, while passing 10% of the sample.
Effluent	Liquid which is discharged from an on-site sewage system component, such as a septic tank (septic tank effluent) or sand filter (sand filter effluent).
Excreta	Human urine and feces.
Experimental System	Any alternative system without design guidelines developed by the department or a proprietary device or method which has not yet been evaluated and approved by the department.
Failure	A condition of an on-site sewage system that threatens the public health by inadequately treating sewage or creating a potential for direct or indirect contact between sewage and the public. Examples of failure include:

Term	Meaning / Description
	sewage on the surface of the ground; sewage backing up into a structure caused by slow absorption of septic tank effluent; sewage leaking from a septic tank, pump chamber, holding tank, or collection system; cesspool or seepage pits where evidence of ground water or surface water quality degradation exists; or inadequately treated effluent contaminating ground water or surface water. noncompliance with standards stipulated on the permit.
Fats, Oils & Greases (Fog)	FOG is a measure of the amount of fatty matter from animal and vegetable sources and hydrocarbons from petroleum products and waxes, such as from lotions, shampoos, and tanning oils. High levels of fats, oils and greases in the wastewater stream may interfere with wastewater treatment efficiency.
Fecal Coliform (Bacteria)	Coliform bacteria specifically originating from the intestines of warm-blooded animals, used as a potential indicator of ground water and/or surface water pollution.
Filter	A device or structure for removing suspended solid or colloidal material from wastewater.
Filter Media	The material through which wastewater is passed for the purpose of treatment (ASTM C-33).
Filtrate	Liquid which has passed through a filter.
Final Treatment/Disposal Unit	That portion of an on-site sewage system designed to provide final treatment and disposal of the effluent from a wastewater treatment unit, including, but not limited to, absorption fields (drainfields), sand mounds and sand-lined trenches.
Fineness Modulus	A numeric quantity to control the distribution of filter media particle sizes within the specified range for intermittent sand filters. It is calculated by adding the cumulative percents of samples retained on the following screens, divided by 100.
Geomembrane	An essentially impermeable membrane used with foundation, soil, rock, earth or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.
Geotextile	Any geotechnical engineering-related permeable textile used with foundations, soil, rock, earth, an integral part of a human-made project, structure, or system, and which serves to lessen the movement of fine soil particles.
Infiltrative Surface	In drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-mound sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.
Influent	Wastewater, partially or completely treated, or in its natural state (raw wastewater), flowing into a reservoir, tank, treatment unit, or disposal unit.
On-Site Sewage System	An integrated arrangement of components for a residence, building, industrial establishment or other places not connected to a public sewer system which: Convey, store, treat, and/or provide subsurface soil treatment and disposal on the property where it originates, upon adjacent or nearby property; and Includes piping, treatment devices, other accessories, and soil underlying the disposal component of the initial and reserve areas.
Particle Size	The diameter of a soil or sand particle, usually measured by sedimentation or sieving.
Percolation	The flow or trickling of a liquid downward through a contact or filtering medium. The liquid may or may not fill the pores of the medium.
Pressure Distribution	A system of small diameter pipes that apply effluent fairly uniformly over the entire absorption area, as described in the "Recommended Standards and Guidance for Pressure Distribution Systems" by the Washington State Department of Health. (See Conventional Pressure Distribution System.)
Proprietary Device Or Method	A device or method classified as an alternative system, or a component thereof, held under a patent, trademark or copyright.
Pump Chamber	A tank or compartment following the septic tank or other pretreatment process which contains a pump, floats and volume for storage of effluent. In timer-controlled pressure distribution systems, this is frequently called a "surge tank" or "equalization tank." If a siphon is used, in lieu of a pump, this is called a "siphon chamber."
Raw Wastewater	Wastewater before it receives any treatment.
Residential Sewage	Sewage having the consistency and strength typical of wastewater from domestic households.
Restrictive Layer	A stratum impeding the vertical movement of water, air, and growth of plant roots, such as hardpan, clay pan, fragipan, caliche, some compacted soils, bedrock and unstructured clay

Term	Meaning / Description
	soils.
Routine Servicing	Servicing all system components as needed, including product manufacturer's requirements / recommendations for service.
Sand Filter	A biological and physical wastewater treatment component consisting (generally) of an under drained bed of sand to which pre-treated effluent is periodically applied. Filtrate collected by the under drains is then disposed of by an approved soil absorption system. Pretreatment can be provided by a septic tank or another approved treatment component. An Intermittent Sand Filter is a sand filter in which pre-treated wastewater is applied periodically providing intermittent periods of wastewater application, followed by periods of drying and oxygenation of the filter bed. A Recirculating Sand (Gravel) Filter is a sand (gravel) filter which processes liquid waste by mixing filtrate with incoming septic tank effluent and recirculating it several times through the filter media before discharging to a final treatment/disposal unit. Sand-Lined Drainfield Trench is a combination of a pressure distribution drainfield and an intermittent sand filter consisting of a two-foot layer of intermittent sand filter media placed directly below the drain rock layer in the pressure distribution drainfield trench. A Bottomless Sand Filter is a special case of a sand-lined drainfield trench installed in a containment vessel and is usually used to utilize more suitable soils high in the soil profile for disposal.
Septic Tank	A water tight pretreatment receptacle receiving the discharge of sewage from a building sewer or sewers, designed and constructed to permit separation of settleable and floating solids from the liquid, detention and anaerobic/facultative digestion of the organic matter, prior to discharge of the liquid.
Service Interval	The time period between planned site visits to perform various system monitoring functions such as checking equipment, renewing depleted disinfectant chemical supply, collecting samples. The service intervals may be specified by contracts, operation plans, or local health jurisdiction permits.
Sewage	Any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, building, industrial establishments or other places. For the purposes of this document, “sewage” is generally synonymous with domestic wastewater. Also see "residential sewage."
Soil Type 1A	Very gravelly coarse sands or coarser, extremely gravelly soils.
Subsurface Soil Absorption System - “SSAS”	A system of trenches three feet or less in width, or beds between three feet and ten feet in width, containing distribution pipe within a layer of clean gravel designed and installed in original, undisturbed soil for the purpose of receiving effluent and transmitting it into the soil.
Suitable Soil	Original, undisturbed soil of types 1B through 6.
Synthetic Filter Fabric	See Geotextile.
Synthetic Membrane	See Geomembrane.
Timer-Controlled System	A pressure distribution system where the pump on and off times are preset, discrete time periods.
Total Suspended Solids (TSS)	Suspended solids refer to the dispersed particulate matter in a wastewater sample that may be retained by a filter medium. Suspended solids may include both settleable and unsettleable solids of both inorganic and organic origin. This parameter is widely used to monitor the performance of the various stages of wastewater treatment, often used in conjunction with BOD5 to describe wastewater strength. The test consists of filtering a known volume of sample through a weighed filter membrane that is then dried and re-weighed.
Treatment Component	A class of on-site sewage system components that modify and/or treat sewage or effluent prior to the effluent being transmitted to another treatment component or a disposal component. Treatment occurs by a variety of physical, chemical, and/or biological means. Constituents of sewage or effluent may be removed or reduced in concentrations.
Treatment Standard 1	A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 200 fecal coliform/100ml.
Treatment Standard 2	A thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 800 fecal coliform/100ml.
Uniformity Coefficient, CU	A numeric quantity which is calculated by dividing the size of the opening which will pass 60% of a sample by the size of the opening which will pass 10% of the sample. (symbolically C60/C10=CU)
Vertical Separation	The depth of unsaturated, original, undisturbed soil of Soil types 1B - 6 between the bottom of a disposal component and the highest seasonal water table, a restrictive layer, or Soil Type 1A.

Term	Meaning / Description
Wastewater	Water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities. (See sewage.)
Wastewater Design Flow	The volume of wastewater predicted to be generated by occupants of a structure. For residential dwellings, this volume is calculated by multiplying the number of bedrooms by the estimated number of gallons per day (gpd), using either the minimum state design standard (120 gpd) or the locally established minimum standard (such as 150 gpd).
Wastewater Treatment Unit	A unit designed, constructed, and installed to stabilize liquid waste by biochemical and physical action.

Appendix H

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